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Analysis of the temporal dynamics of model performance and parameter sensitivity for hydrological models

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The temporal dynamics of hydrological model performance gives insights into errors that cannot be obtained from global performance measures assigning a single number to the fit of a simulated time series to an observed reference series. These errors can include errors in data, model parameters, or model structure. Dealing with a set of performance measures evaluated at a high temporal resolution implies analyzing and interpreting a high dimensional data set. We present a method for such a hydrological model performance assessment with a high temporal resolution. Information about possible relevant processes during times with distinct model performance is obtained from parameter sensitivity analysis - also with high temporal resolution. We illustrate the combined approach of temporally resolved model performance and parameter sensitivity for a rainfall-runoff modeling case study. The headwater catchment of the Wilde Weisseritz in the eastern Ore mountains is simulated with the conceptual model WaSiM-ETH. The proposed time-resolved performance assessment starts with the computation of a large set of classically used performance measures for a moving window. The key of the developed approach is a data-reduction method based on self-organizing maps (SOMs) and cluster analysis to classify the high-dimensional performance matrix. Synthetic peak errors are used to interpret the resulting error classes. The temporally resolved sensitivity analysis is based on the FAST algorithm. The final outcome of the proposed method is a time series of the occurrence of dominant error types as well as a time series of the relative parameter sensitivity. For the two case studies analyzed here, 6 error types have been identified. They show clear temporal patterns which can lead to the identification of model structural errors. The parameter sensitivity helps to identify the relevant model parts.